WATER QUALITY STUDIES

OF

RONDEAU BAY AND WATERSHED

KENT COUNTY

Ministry
of the
Environment

Ontario

Water Quality Studies of Rondeau Bay and Watershed

Kent County

Water Resources Assessment Unit
Technical Support
Southwestern Region
Field Work 1981
Report Preparation - 1982

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1.0 SUMMARY AND DISCUSSION

Rondeau Bay over the years has been characterized by luxurient growths of rooted aquatic plants. The Bay also supported a first-rate warm water fishery. Largemouth bass fishing was excellent, drawing fishermen from many parts of Canada and the United States.

Unfortunately, this situation no longer exists. The Bay is now almost devoid of rooted aquatic plants, its waters are turbid brown for most of the year and its warm water fishery has been seriously degraded.

The decline in the general ecology of Rondeau Bay can be explained to a great extent by the studies carried out by the Ministry of the Environment during the year of 1981. These studies concluded that severe sheet erosion from the adjoining intensively row cropped agricultural land is fouling the Bay with suspended sediments (silt).

The following results and findings highlight the 1981 study:

1. Suspended solids and turbidity levels are extremely high, exceeding guidelines for the protection of aquatic life (fish, plants, aquatic insects and other organisms).

2. Phosphorus levels exceed Ministry of the Environment guidelines at all sampling locations in Rondeau Bay.

3. Secchi disc (water clarity) measurements were extremely low throughout Rondeau Bay. The swimming and bathing use water guidelines of 1.2 meters for safe recreational use were violated at all sampling locations throughout

the study period. From a long-term standpoint, it may be fortuitous that above average rainfall conditions during June, 1981 dramatized the fact that serious soil losses are occurring within the watershed on an annual basis as a result of spring runoff and summer storm events.

4. Chlorophyll levels were extremely low, indicating a depressed algae community due to lack of sunlight penetration into the water column.

5. Aerial photography and ground location pictures document the severe sheet erosion occurring on agricultural land in the Rondeau Bay watershed.

These sediments loads were measured as high as 63,000 mg/l in drains entering Rondeau Bay, or in simpler terms, 6% of the sample collected was sediments. To help bring these figures into context, the Thames River at Lake St. Clair during spring runoff would have suspended solid levels of 500 mg/l or less.

The findings of this study, while influenced by the higher-than average rainfall, strongly suggest that current agricultural practices have led to the decline of the fishing in Rondeau Bay through extreme siltation. Immediate corrective action is essential to restore the fishery and to protect valuable soil resources in the Rondeau Bay watershed in order to sustain optimum agricultural production over the long-term.

The Bay is no longer aesthetically pleasing. Its waters are murky brown. Recreational uses such as swimming have degraded significantly. The Ministry of the Environment guideline for water clarity of 1.2 meters to ensure safe recreational use was never attained during the study and the majority of the sampling locations averaged less than .5 meters.

Rondeau Bay, a prime ecological and recreational resource, is being severely degraded by intensive farming practices. The Rondeau Bay situation calls for all farmers in the watershed to initiate basic soil conservation methods immediately.

The reasons for employing soil conservation measures are not restricted to the water quality and fishery of Rondeau Bay. With the apparent soil and crop losses that are occurring in the watershed, it is unfortunate that basic soil conservation methods are being seriously neglected. Such measures are essential to retain and re-establish fertile, well-structured soils as a basis for sustained agricultural production. Many of the hilly areas of the watershed have already lost top soil to the extent where the less permeable sub-soils are showing through. If erosion is left unchecked, the disappearance of top soil will result in continued escalation of tillage and fertilizer costs, increased susceptibility to precipitation effects and reduced crop yields.

2.0 RECOMMENDATIONS

1. Recommendations from this study must naturally be directed to soil conservation. Measures such as conservation tillage, cross-slope tillage, grassed waterways, crop rotations, buffer strips along drains, and improved drain construction should be considered and applied, where applicable, to reduce soil erosion.

2. A task force should be developed to oversee a program for assessing site-specific soil conservation requirements and to stimulate receptivity in the farming community for implementation of soil conservation measures. This should include fostering the use of government grants, including the Farm Productivity Incentive Program of the Ministry of Agriculture and Food, to assist with soil conservation efforts. It is suggested that the task force consist of representatives from the Ministry of Agriculture and Food, the Ministry of Natural Resources, the Lower Thames River Conservation Authority, the Ministry of the Environment and a local farming group.

3.0 INTRODUCTION

Rondeau Bay is located along the north shore of Lake Erie's central basin in the southerly portion of Harwich Township, Kent County (Figure 1).

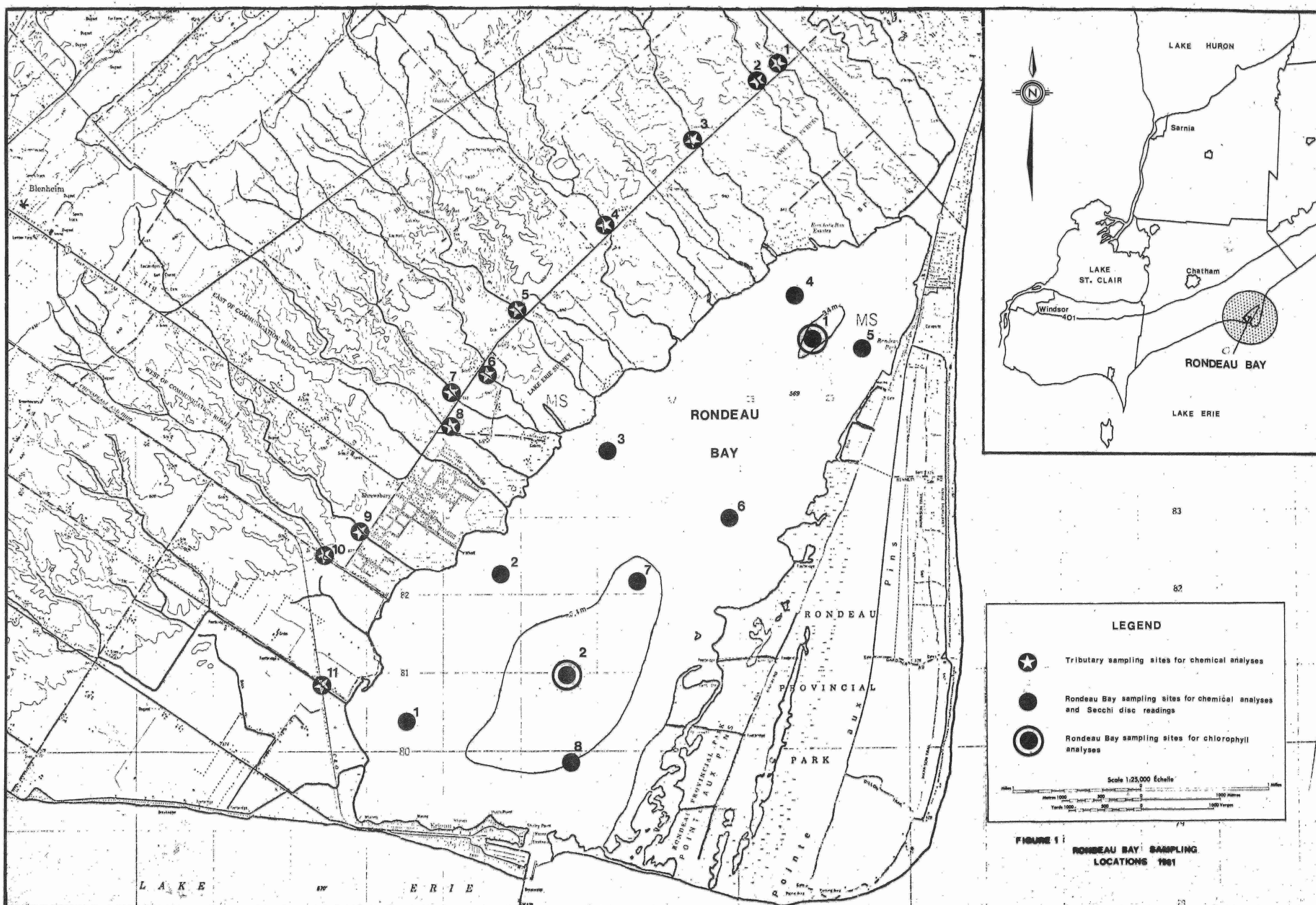

FIGURE 1 : RONDEAU BAY SAMPLING LOCATIONS 1981

The bay is approximately 10.5 km long by 4 km wide and covers an area of approximately 2700 hectares.

The Ministry of Natural Resources has defined Rondeau Bay as being one of the most important water recreation areas along the north shore of Lake Erie. Two publications, Summer and Winter Creel Census on Rondeau Bay, Lake Erie 1980 and a draft report entitled Rondeau Bay, Recreation Access Study, 1978, provide a good insight into the recreational and fishery potential of Rondeau Bay and watershed.

During the summer of 1977 a sudden die-off of aquatic macrophytes (rooted aquatic plants) occurred throughout Rondeau Bay. Investigations by this Ministry during 1977 revealed no obvious cause. Prior to 1977, the aquatic plant community was dominated by Eurasian milfoil. Eurasian milfoil similarly dominated the macrophyte community in many other lakes in Ontario and in the Northeastern United States in the mid-1970's. About 1977, Eurasian milfoil showed a rapid decline in many of these bodies of water (references 15 and 16). The reason(s) for this milfoil decline are basically unknown, although various possibilities have been advanced (reference 15).

In most of the milfoil lakes that have been studied, the milfoil collapse has resulted in a return to a more diversified plant community. Rondeau Bay, however, would appear to be an exception in that the plant growth has remained very sparse since the 1977 milfoil decline.

Chemical analyses of the water indicated luxurient nutrient levels existed in the Bay, which should encourage aquatic plant growth. High suspended solid levels and turbidity were also indicated by the analyses. These parameters, if high enough, would have a serious detrimental effect on plant growth.

During the same period, 1977-1980, the Ministry of Natural Resources documented a major decline in the Rondeau Bay fishery (reference 14). The study also documented decreases in fishing pressure and the number of non-resident fishermen since 1977.

Complaints were received from resort operators at Erieau regarding a decline in water quality (the Bay had become visually more turbid brown). Concerns regarding a decline in water quality in Rondeau Bay were brought to the attention of the Ministry of the Environment by the public, resort operators, the news media and the Ministry of Natural Resources.

As a result of these concerns, further studies were scheduled for the year 1981. Although earlier investigations did not specifically pinpoint any one reason for problems at Rondeau Bay, the occurrence of turbid water conditions was becoming more obvious. The 1981 studies were set up to document and define the extent of the water clarity and turbidity problems in Rondeau Bay.

4.0 STUDIES CARRIED OUT ON RONDEAU BAY DURING 1981

The following work was carried out during the spring and summer of 1981 to address the apparent water clarity problem in Rondeau Bay.

Aerial flights were made over Rondeau Bay and watershed during April and June, 1981. Aerial photographs were taken of sediment plumes in Rondeau Bay and erosion situations in the watershed. On-land photographs of erosion

problems were also taken. During June, 1981 agricultural drains entering Rondeau Bay were sampled four times. Water samples from these drains were tested for the following parameters: total phosphorus, soluble phosphorus, free ammonia, Kjeldahl nitrogen, nitrate, nitrite, pH, turbidity, suspended solids and chloride.

Primarily during June, chemical sampling was carried out at eight stations throughout Rondeau Bay (figure 1) for the following chemical parameters: total phosphorus, soluble phosphorus, free ammonia, Kjeldahl nitrogen, nitrate, nitrite, pH, turbidity, suspended solids, and chlorides. Secchi disc readings were collected at all eight stations from June to August 25, 1981 (see Table 4).

During June to August, 1981 phytoplankton and Chlorophyll samples and secchi disc readings were collected weekly at two locations (see Figure 1). These locations were situated at the two deepest areas in Rondeau Bay.

To help enhance the field studies, a literature research was carried out on the effects of siltation on aquatic life (plants, fish, etc.).

5.0 DISCUSSION OF RESULTS

5.1 Plates

Plates 1 - 6 illustrate some of the key visual observations made during the study.

5.2 Rainfall Records

Even before the 1981 field study began, a strong relationship between rainfall events and Bay turbidity was suspected. In order to determine how typical rainfall and Bay conditions were during the present survey, rainfall records at the Windsor and Chatham Airports were reviewed for the 1977 - 1981 summer periods.

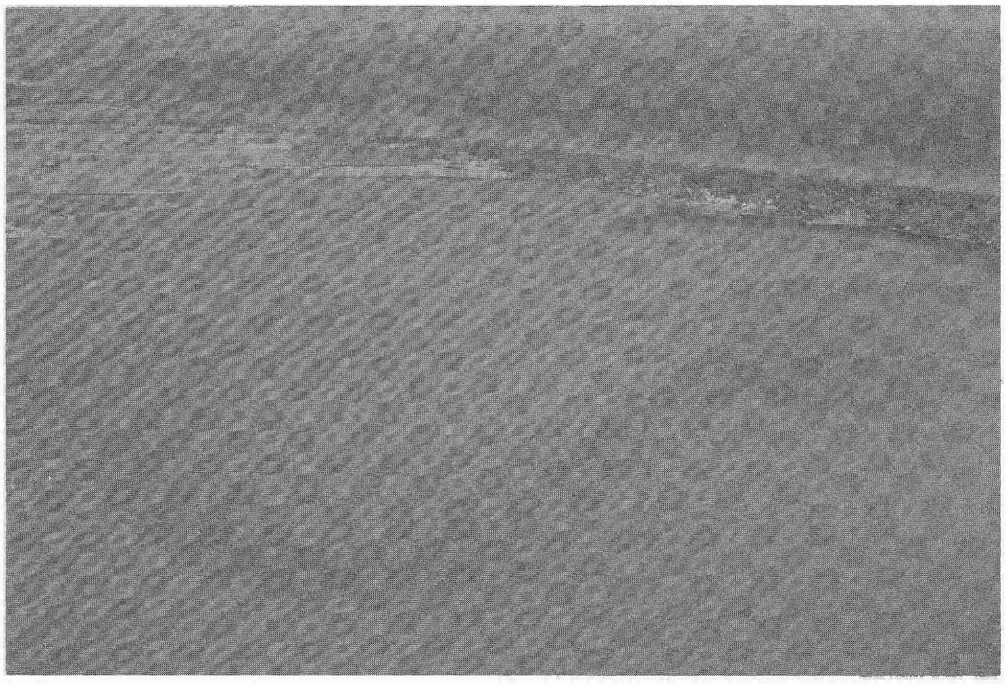

Plate 1. Aerial view of the north end of Rondeau Bay with Lake Erie in the background, June 5, 1981. Note the contrasting water colours between Rondeau Bay (lower) and Lake Erie (upper).

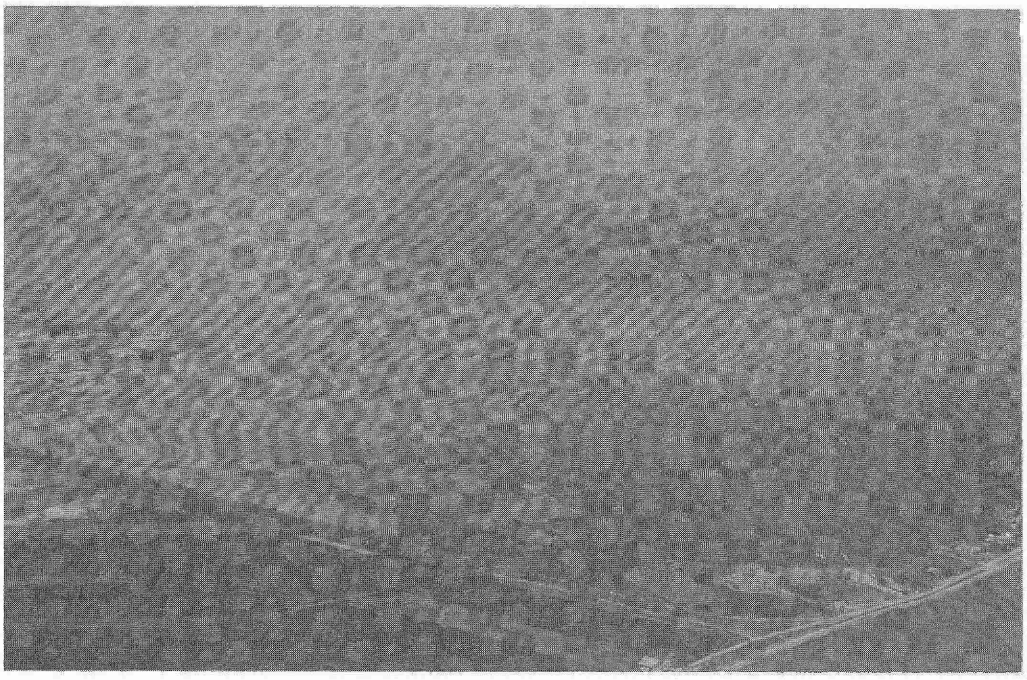

Plate 2. Aerial view of Rondeau Bay, June 5, 1981. Note the turbidity plumes entering the Bay along the west shoreline.

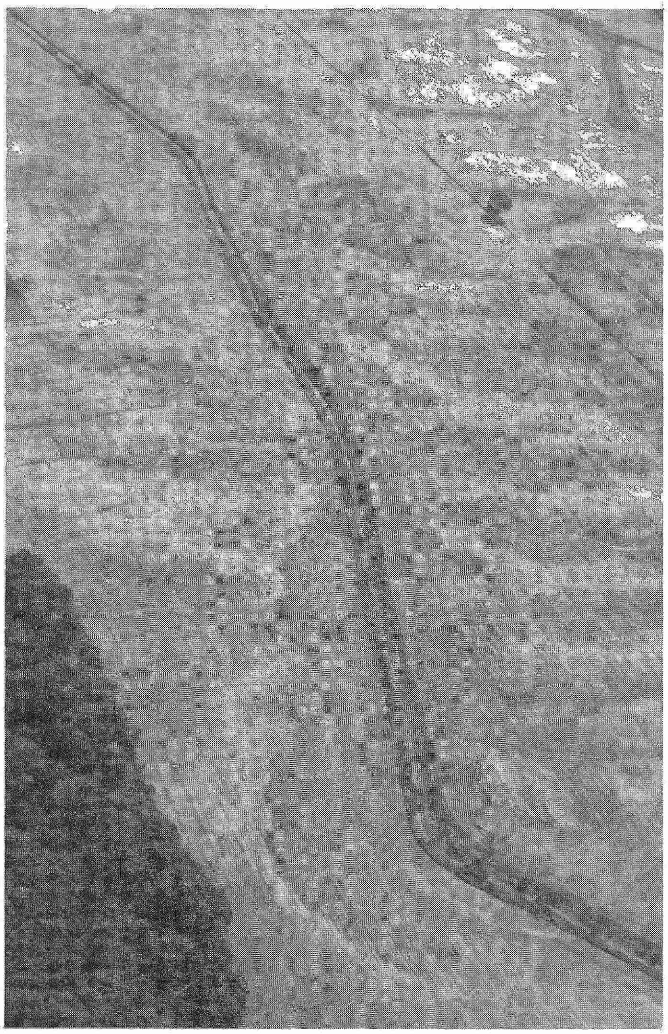

Plate 3. Aerial view of sheet erosion along a drain in the Rondeau Bay watershed, June 5, 1981.

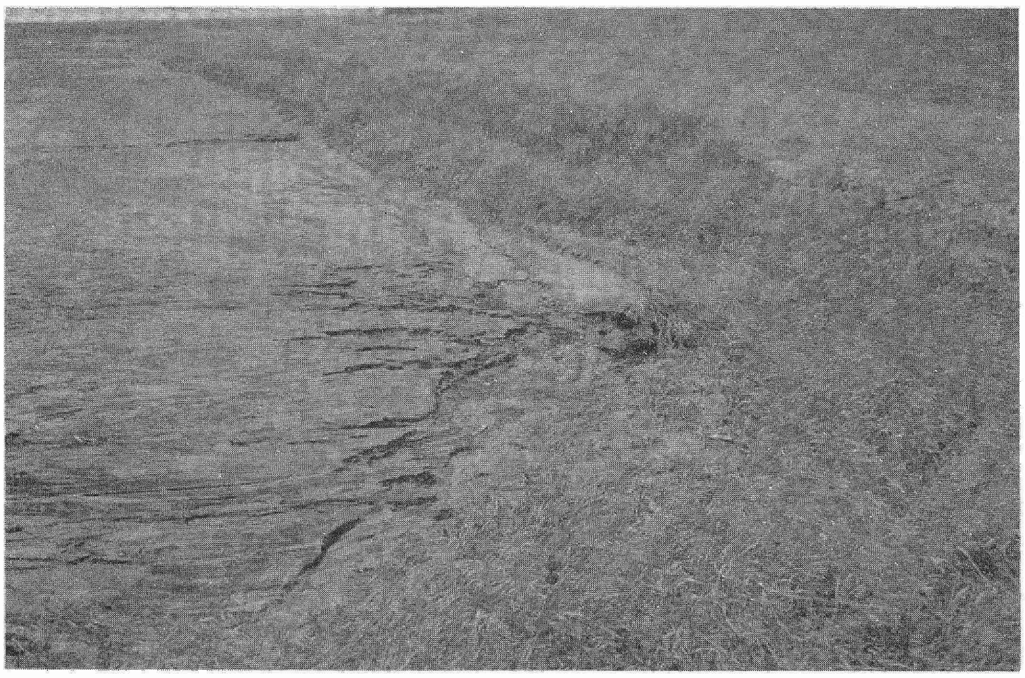

Plate 4. Ground view of erosion along a drain in the Rondeau Bay watershed, June 4, 1981.

Plate 5. Ground view of erosion occurring on cultivated field in the Rondeau Bay watershed, June 4, 1981.

Plate 6. Ground view of erosion from flash flooding on the Rondeau Bay watershed, June 10, 1981.

The summer of 1977 was abnormally wet, with higher than normal rainfall levels for June, July and August. Abnormally dry conditions were present for the entire summer of 1978. The summer months of 1979 were also abnormally dry with the exception of July which was abnormally wet.

June and August, 1980 were the wettest June and August over the 1977 - 1981 period, July, 1980 rainfall was average.

Rainfall levels were substantially above normal for June, July and August, 1981. July, 1981 was the wettest July during the 1977 - 1981 period.

During June, 1981 a number of localized intense thunderstorms occurred in the Rondeau Bay Area, causing severe erosion and flooding of crops. A very severe storm occurred on the evening of June 8, 1981 between 10:00 and 11:00 p.m. The Chatham weather station documented 25 mm of rain, however, the storm appeared to be more intense at Rondeau Bay and probably was the most intensive storm over the 1977 - 1981 period.

It is during these short intensive thunderstorms when severe erosion occurs. Long-term weather records between 1977 - 1981 indicate thunderstorm numbers have been higher than normal.

Plate 1 and 2 on page 9 visually display the after effects of intense localized thunderstorms on June 3, 1981. Plate 6, page 11 depicts the results of flash flooding from a very severe thunderstorm on June 8, 1981.

The heavy turbidity documented in Rondeau Bay during this study largely reflects the amount of erosion damage caused by the short intense thunderstorms noted above.

5.3 Literature Review

The effects of high suspended solids levels on the aquatic environment are well documented in the literature (references 5, 4 and 2). Studies in Illinois streams (reference 1) concluded that excessive siltation ranks first and is the principle cause for the elimination of two native fish species and the decimation of fourteen others. The effects of siltation included loss of water clarity and the subsequent disappearance of aquatic vegetation and the deposition of silt over feeding and spawning sites.

Reduction of feeding rates (reference 7) and behavioural changes (reference 8) are directly related to suspended solids levels. A six-fold drop in production of bluegills and largemouth bass occurred in turbid Oklahoma ponds (reference 13).

Aquatic vegetation is greatly affected by reduced light conditions (references 3, 4, 5, 6, 9, 11 and 12). Relation of plant distribution and growth to mean water transparency is documented throughout the literature. In badly polluted water, the overall extinction of light is often rapid (reference 5). Photosynthesis can be greatly reduced, and the settling of silt particles may smother existing vegetation (references 4, 7, 4 and 2).

5.4 Total Phosphorus

To avoid nuisance concentrations of algae in lakes, average total phosphorus concentration for the ice-free period of the year should not exceed .02 mg/l.

Every sample collected from Rondeau Bay and watershed during 1981 exceeded the .02 mg/l guideline. Total phosphorus levels in excess of 30.0 mg/l were measured in drains during storm events. Stations 3 and 4 in Rondeau Bay produced the highest averages for the Bay, .166 mg/l and .144 mg/l total phosphorus respectively during the period June to August, 1981 (see Tables 1 and 2).

5.5 Free Ammonia

Concentrations of un-ionized ammonia should not exceed .02 mg/l for the protection of aquatic life. All samples collected from Rondeau Bay proper were within the guidelines; however, sampling from drains in the watershed during storm events exceeded the .02 mg/l guideline.

5.6 Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen includes the organic nitrogen compounds (soluble and particulate) plus the ammonia fraction. While no guidelines have been established for this parameter, levels in streams unaffected by man's activities are usually less than 0.5 mg/l. Values in Rondeau Bay were moderately higher ranging from .4 to 2.1 mg/l. Extremely high levels, to 84.0 mg/l maximum, were recorded in drains during storm events.

5.7 Nitrite and Nitrate

Nitrate and nitrite are usually found at levels less than .1 mg/l in natural virgin systems. Moderately high nitrate levels were present in Rondeau Bay. Drains entering Rondeau Bay had nitrate values as high as 18 mg/l.

Table 1. Average values for seven samplings of Phosphorus and Suspended Solids at 8 stations on Rondeau Bay during June, July, 1981.

Station	Phosphorus mg/L Total	Soluble	Suspended Solids mg/L
1	.047	.013	14.1
2	.077	.012	21.1
3	.166	.037	56.9
4	.144	.031	46.33
5	.083	.017	25.6
6	.048	.008	13.1
7	.059	.016	11.0
8	.043	.009	8.21

Table 2 . Phosphorus and Suspended Solids data collected during June, 1981 from eleven drains which discharge to Rondeau Bay.

Station Date	Phosphorus Total	Phosphorus Soluble	Suspended Solids mg/L	Remarks
Sta #1				
June 8	.136	.042	50.9	- before rainfall
June 8	12.8	3.45	20610.0	- after heavy rainfall
June 10	.236	.065	124.0	- no rainfall
June 15	.82	.151	430.4	- one day after heavy rainfall
Sta #2				
	.149	.096	11.9	
	21.5	3.65	23441.0	
	.194	.073	164.4	
	.580	.125	239.7	
Sta #3				
	25.3	4.70	26383.0	
	.262	.046	164.4	
	.720	.094	388.2	
Sta #4				
	.142	.023	68.7	
	20.3	3.35	17945	
	.198	.053	89.1	
	.420	.097	131.7	
Sta #5				
	.136	.032	48.5	
	16.0	4.40	16121	
	.244	.086	78.8	
	1.28	.167	752.4	
Sta #6				
	.170	.054	54.0	
	18.8	4.30	34782.0	
	.172	.110	14.9	
	.440	.174	79.6	
Sta #7				
	.138	.044	31.4	
	24.8	5.75	32729	
	.164	.058	63.1	
	.33	.082	198.7	
Sta #8				
	.150	.034	55.0	
	31.5	3.45	63251.0	
	.218	.059	80.8	
	.280	.096	124.8	

Table 2 . (continued)

Station Date	Phosphorus Total	Phosphorus Soluble	Suspended Solids mg/L	Remarks
Sta #9				
	.150	.034	55.0	
	16.3	3.80	53772.0	
	.630	.132	318.1	
	.600	.187	220.6	
Sta #10				
	.430	.165	71.0	
	.570	.052	468.7	
	.246	.077	104.4	
	.410	.184	120.2	
Sta #11				
	.286	.057	104.0	
	.216	.060	100.5	
	.495	.075	226.7	
	.730	.230	148.6	

5.8 Chloride

Chloride levels were generally low in Rondeau Bay with concentrations ranging from 12 mg/l to 19 mg/l. Samples from drains entering the bay ranged from 3.5 mg/l to 52 mg/l.

5.9 Suspended Solids

Suspended matter should not be added to surface water in concentrations that will change the natural secchi disc reading by more than 10%. Naturally clear water bodies usually would have a suspended solids level of less than 5 mg/l. Individual levels in Rondeau Bay ranged from a low at station 8 of 4.5 mg/l to a high of 220 mg/l at station 3. Drains sampled in the adjoining watershed ranged from 11.9 mg/l during clear weather to in excess of 63,000 mg/l during a severe storm event.

5.10 Turbidity

Water clarity is one of the main criteria used by the public to judge water quality for drinking and recreational use.

Materials present in water absorb, scatter and reflect light as it passes through it. Dissolved materials act to limit the penetration of light down through the water column. Turbidity is a measure of the optical properties of a sample which cause light to be scattered rather than transmitted in straight lines through the sample. In water samples, turbidity is a result of suspended clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms. While shoreline erosion, resuspension of sediment material and algal blooms decrease light transmission naturally, human activities causing overland transport of soil to surface waters (siltation) can also have a substantial effect.

Turbidity cannot be successfully correlated with the suspended solids test because the size, shape, refractive index and hence, the light scattering effect of the suspended matter have little relationship to the concentration of specific gravity of the suspended matter.

Turbidity measurements in Rondeau Bay during June, 1981 indicate very high and erratic turbid conditions. Water at Stations 3 and 4 located on the northwesterly side of the Bay, was the most turbid, with average Formazin Turbidity Units (FTU's) of 80 and 53 respectively for four samplings. The remaining six locations averaged between 10 FTU at Station 8 and 18 FTU at Station 1. Levels greater than 22 FTU were recorded at least once at each of the eight sampling locations in June, 1981.

Tributaries entering Rondeau Bay were documented to have excessive turbidity levels. Levels greater than 1000 FTU were documented after a heavy rainfall event on June 8, 1981 in 9 out of 11 tributaries.

The turbidity of the water can have a great effect on the types and quantities of algae that grow in it by altering the amount of light available for photosynthesis. Suspended matter should not be added to surface waters in concentrations that will change the natural secchi disc reading by more than 10 percent. Table 3 outlines some of the biological effects of elevated turbidity that have been documented in the literature.

Table 3. Reported effect of sediment and turbidity on aquatic life (after Illinois EPA 1979).

Level	Biological Effect	References (cited in Illinois EPA 1979)
14-16 JTU's*	Largemouth bass activity reduced, social behaviour of green sunfish altered, and coughing and scraping increased.	Heimstra, Damkot and Benson 1969
20 JTU's	Reactive distance of bluegill reduced by 50% in comparison to reactive distance in clear water.	Vinyard and O'Brien 1976
30 JTU's	Reactive distance of bluegill reduced by 80%. Upper limit for effect on bluegill reactive distance.	Vinyard and O'Brien 1976
25-50 JTU's	80% reduction in net plankton, compared to plankton production in clear farm ponds (25 JTU's).	Claffey 1955
51-350 JTU's	90% reduction in net plankton, compared to plankton production in clear farm pond (25 JTU's).	Claffey 1955
84 JTU's	Highest turbidity in which largemouth bass were able to spawn.	Buck 1956a
100 JTU's	Spawning success to redear and bluegill severely restricted or completely restricted above this level.	Buck 1956a
25-100 JTU's	42% reduction in total weight of largemouth bass, redear sunfish, and bluegills produced in farm ponds, relative to total production in clear farm ponds. 49% reduction in average weight gain and 26% reduction in average length increase of young bass after two growing seasons, in comparison to gains by bass in clear ponds.	Buck 1956a
1100 JTU's	82% reduction in total weight of largemouth bass, redear sunfish and bluegills produced in farm ponds, relative to total production in clear farm ponds. 92% reduction in average weight gain and 65% reduction in average length increase of young bass after two growing seasons, in comparison to gains by bass in clear ponds.	Buck 1956a

Table 3. continued

Level	Biological Effect	References (cited in Illinois EPA 1979)
An increase in suspended sediment (limestone dust) from 9.7 to 28.3 mg/L.	26% increase in Macroinvertebrate drift.	Gammon 1970
An increase in suspended sediment (limestone dust) from 20.3 to 125.0 mg/L	90% increase in Macroinvertebrate drift.	Gammon 1970
38,250 JTU's	Lethal to rock bass.[a]	Wallen 1951
85,000 JTU's	Lethal to channel catfish.[a]	Wallen 1951
101,000 JTU's	Lethal to largemouth bass.[a]	Wallen 1951

[a] Death occurred after 15 mintues to two hours exposure.

* Formazin Turbidity Units (FTU) ≈ Jackson Turbidity Units (JTU)

5.11 Secchi Disc Readings

As indicated earlier, water clarity, which governs the depth of light penetration in a lake is one of the most important parameters used in defining water quality. A simple method for measuring water clarity is by use of a secchi disc.

The disc is divided into black and white alternating quadrats and is lowered into the water on a graduated line until the quadrats cannot be distinguished. The depth at which the disc just disappears is termed the secchi disc depth (see Figure 2).

Secchi disc readings in Rondeau Bay were extremely low during the study period (see Table 4). Readings varied from an average of .81 meters at Station 8 to an average of .29 meters at Station 4.

Ministry of the Environment guidelines for swimming and bathing use of water state in part; water used for swimming, bathing and other recreational activities should be aesthetically pleasing. The water should be devoid of debris, oil, scum and any substance which would produce an objectionable deposit, colour, odour, taste or turbidity.

The water in bathing areas should be sufficiently clear to estimate depth or to see submerged swimmers who may require assistance. To achieve this degree of safety, water clarity should be such that, if the bottom of the bathing area is not visible, the water should have a secchi disc transparency of at least 1.2 meters.

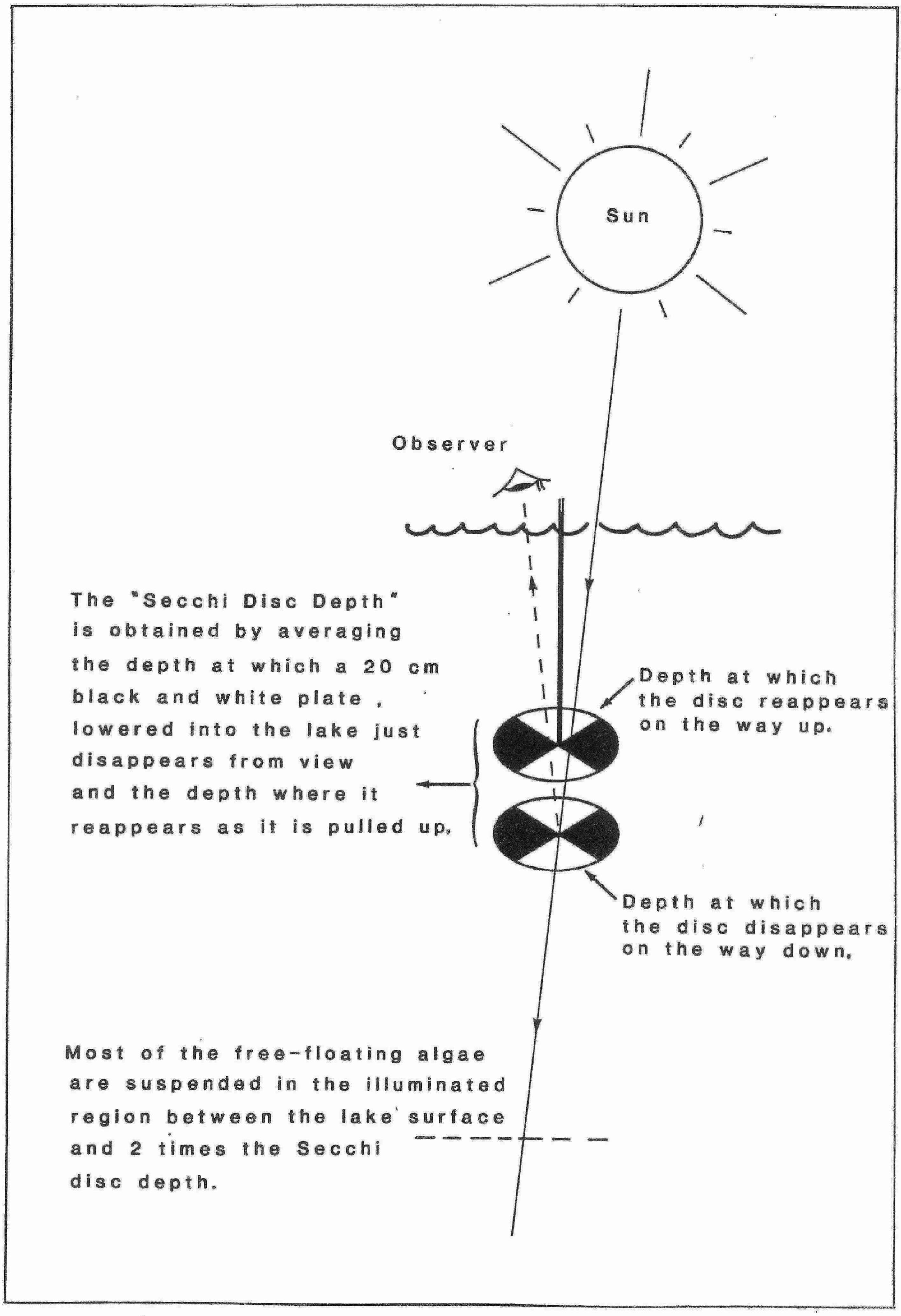

Figure 2. The use of a Secchi disc to measure water clarity.

Table 4. Rondeau Bay Secchi Disc Data

Station Number	Date 1981	Time of Sampling	Secchi Disc Reading (m)	Temperature °C
1	June 2	2:00 p.m.	0.6	18.5
	June 4	10:55 a.m.	0.4	17.5
	June 10	3:05 p.m.	0.15	18.0
	June 18		0.5	20.0
	June 23	3:27 p.m.	0.6	19.5
	June 28	3:10 p.m.	0.2	21.0
	July 5	10:30 a.m.	0.4	22.0
	July 10	9:10 a.m.	0.65	22.0
	July 14	5:05 p.m.	0.5	23.5
	July 23	10:45 a.m.	0.25	21.5
	July 29	3:55 p.m.	0.35	22.0
	Aug 3	10:00 a.m.	0.6	24.0
	Aug 15	4:00 p.m.	0.5	23.0
	Aug 17	8:50 a.m.	0.35	19.0
	Aug 25	3:45 p.m.	0.3	24.0
			Average 0.43	
			Maximum 0.65	
			Minimum 0.2	
2	June 2	1:55 p.m.	0.8	18.0
	June 4	11:00 a.m.	0.8	18.0
	June 10	3:15 p.m.	0.12	19.0
	June 18		0.4	19.5
	June 23	3:20 p.m.	0.5	19.5
	June 28	2:50 p.m.	0.3	21.0
	July 5	10:50 a.m.	0.25	24.0
	July 10	8:55 a.m.	0.6	23.0
	July 14	5:15 p.m.	0.7	24.0
	July 23	11:07 a.m.	0.25	21.0
	July 29	3:50 p.m.	0.4	22.0
	Aug 3	10:30 a.m.	0.4	25.0
	Aug 15	4:15 p.m.	0.4	25.0
	Aug 17	8:45 a.m.	0.25	19.0
	Aug 25	3:50 p.m.	0.35	23.0
			Average 0.43	
			Maximum 0.8	
			Minimum 0.12	

Table 4. (continued)

Station Number	Date 1981	Time of Sampling	Secchi Disc Reading (m)	Temperature °C
3	June 2	1:45 p.m.	1.0	18.0
	June 4	11:05 a.m.	0.2	19.0
	June 10	3:25 p.m.	0.4	20.0
	June 18		0.4	21.0
	June 23	3:08 p.m.	0.25	20.0
	June 28	2:40 p.m.	0.15	22.0
	July 5	11:15 a.m.	0.3	25.0
	July 10	8:45 a.m.	0.2	24.0
	July 14	5:20 p.m.	0.5	24.5
	July 23	11:30 a.m.	0.2	20.5
	July 29	3:45 p.m.	0.3	22.0
	Aug 3	10:10 a.m.	0.4	25.0
	Aug 15	2:30 p.m.	0.5	21.0
	Aug 17	8:30 a.m.	0.25	21.0
	Aug 25	4:10 p.m.	0.3	24.0
			Average 0.36	
			Maximum 1.0	
			Minimum 0.15	
4	June 2	1:00 p.m.	1.0	17.0
	June 4	11:15 a.m.	0.2	18.5
	June 10	3:45 p.m.	0.4	20
	June 18		0.1	22.0
	June 23	3:08 p.m.	0.25	20.5
	June 28	2:25 p.m.	0.2	23.0
	July 5	11:25 a.m.	0.25	25.0
	July 10	8:35 a.m.	0.25	25.0
	July 14	--	--	--
	July 23	11:45 a.m.	0.2	21.0
	July 29	3:30 p.m.	0.15	21.0
	Aug 3	9:50 a.m.	0.15	26.0
	Aug 15	4:40 p.m.	0.20	24.0
	Aug 17	8:15 a.m.	0.25	20.0
	Aug 25	4:15 p.m.	0.4	24.0
			Average 0.29	
			Maximum 1.0	
			Minimum 0.1	

Table 4. (continued)

Station Number	Date 1981	Time of Sampling	Secchi Disc Reading (m)	Temperature °C
5	June 2	1:05 p.m.	1.0	17.0
	June 4	11:30 a.m.	1.0	19.0
	June 10	3:50 p.m.	0.4	20
	June 18		0.3	22.0
	June 23	3:05 p.m.	0.4	20.0
	June 28	2:00 p.m.	0.25	24.0
	July 5	8:20 a.m.	0.2	24.0
	July 10	8:00 a.m.	0.15	25.0
	July 14	2:20 p.m.	0.3	25.0
	July 23	9:00 a.m.	0.2	21.0
	July 29	3:15 p.m.	0.2	23.0
	Aug 3	8:07 a.m.	0.2	25.0
	Aug 15	2:10 p.m.	0.15	24.0
	Aug 17	8:10 a.m.	0.15	20.0
	Aug 25	2:35 p.m.	0.4	24.0
			Average 0.35	
			Maximum 1.0	
			Minimum 0.15	
6	June 2	1:30 p.m.	1.0	17.0
	June 4	11:45 a.m.	1.0	18.8
	June 10	3:55 p.m.	0.45	20
	June 18		0.3	22.0
	June 23	3:00 p.m.	0.4	19.0
	June 28	5:40 p.m.	0.4	23.0
	July 5	8:40 a.m.	1.4	23.0
	July 10	--	--	--
	July 14	3:15 p.m.	0.95	25.0
	July 23	9:20 a.m.	0.35	21.0
	July 29	4:50 p.m.	0.5	22.0
	Aug 3	8:35 a.m.	0.55	25.0
	Aug 15	2:40 p.m.	0.5	23.0
	Aug 17	11:30 a.m.	0.15	21.5
	Aug 25	2:50 p.m.	0.5	23.0
			Average 0.6	
			Maximum 1.4	
			Miimum 0.15	

Table 4. (continued)

Station Number	Date 1981	Time of Sampling	Secchi Disc Reading (m)	Temperature °C
7	June 2	1:35 p.m.	1.0	17.5
	June 4	12:00 a.m.	1.0	18.0
	June 10	4:00 p.m.	0.25	20
	June 18		0.4	22.0
	June 23	2:50 p.m.	0.75	19.0
	June 28	5:30 p.m.	0.9	22.0
	July 5	10:10 a.m.	2.2	23.0
	July 10	9:25 a.m.	0.9	23.0
	July 14	3:30 p.m.	0.9	25.0
	July 23	9:30 a.m.	0.45	21.0
	July 29	4:45 p.m.	0.5	22.0
	Aug 3	8:45 a.m.	0.75	24.0
	Aug 15	2:50 p.m.	0.45	23.0
	Aug 17	9:50 p.m.	0.3	19.0
	Aug 25	3:00 p.m.	0.4	22.5
			Average 0.81	
			Maximum 2.2	
			Minimum 0.25	
8	June 2	2:30 p.m.	1.0	17.0
	June 4	12:10 p.m.	1.0	18.0
	June 10	4:05 p.m.	0.45	20.0
	June 18		0.5	22.0
	June 23	2:40 p.m.	0.75	17.0
	June 28	5:00 p.m.	0.7	20.0
	July 5	9:45 a.m.	1.7	23.0
	July 10	--	--	--
	July 14	4:50 p.m.	0.8	24.0
	July 23	10:30 a.m.	1.0	20.0
	July 29	4:10 p.m.	0.55	21.5
	Aug 3	9:55 a.m.	0.9	23.5
	Aug 15	3:15 p.m.	0.45	20.0
	Aug 17	9:15 a.m.	0.5	20.0
	Aug 25	3:15 p.m.	0.6	24.0
			Average 0.78	
			Maximum 1.7	
			Minimum 0.45	

5.12 Chlorophyll

Chlorophyll is a natural pigment component of all green plants. The quantity of chlorophyll in a water sample is therefore, a good indication of how much plant material is present.

Chlorophyll results are normally reported as chlorophyll _a_, chlorophyll _b_ and acidified chlorophyll _a_. Generally, the acidified chlorophyll _a_ result is considered most useful because it represents a pigment contribution of living cells. Chlorophyll _a_ represents a total pigment in both living and dead cells. Chlorophyll _b_ is usually present at very low levels and therefore, its interpretive value is limited.

The large blooms of suspended algae which materialize from excessive inputs of nutrients, result in turbid water or poor clarity or transparency. On the other hand, lakes with only small natural inputs of nutrients and correspondingly low nutrient concentrations most often support very small amounts of algae and consequently are clear-water lakes. An indication of the degree of enrichment of lakes can therefore be gained by measuring the density of suspended algae (as indicated by chlorophyll _a_) and water clarity (measured with a secchi disc). In this regard, staff of the Ministry of the Environment have collected chlorophyll _a_ and water clarity data from numerous lakes in Ontario and have developed a graphical relationship between these parameters. Figure 3 illustrates the above-mentioned relationship.

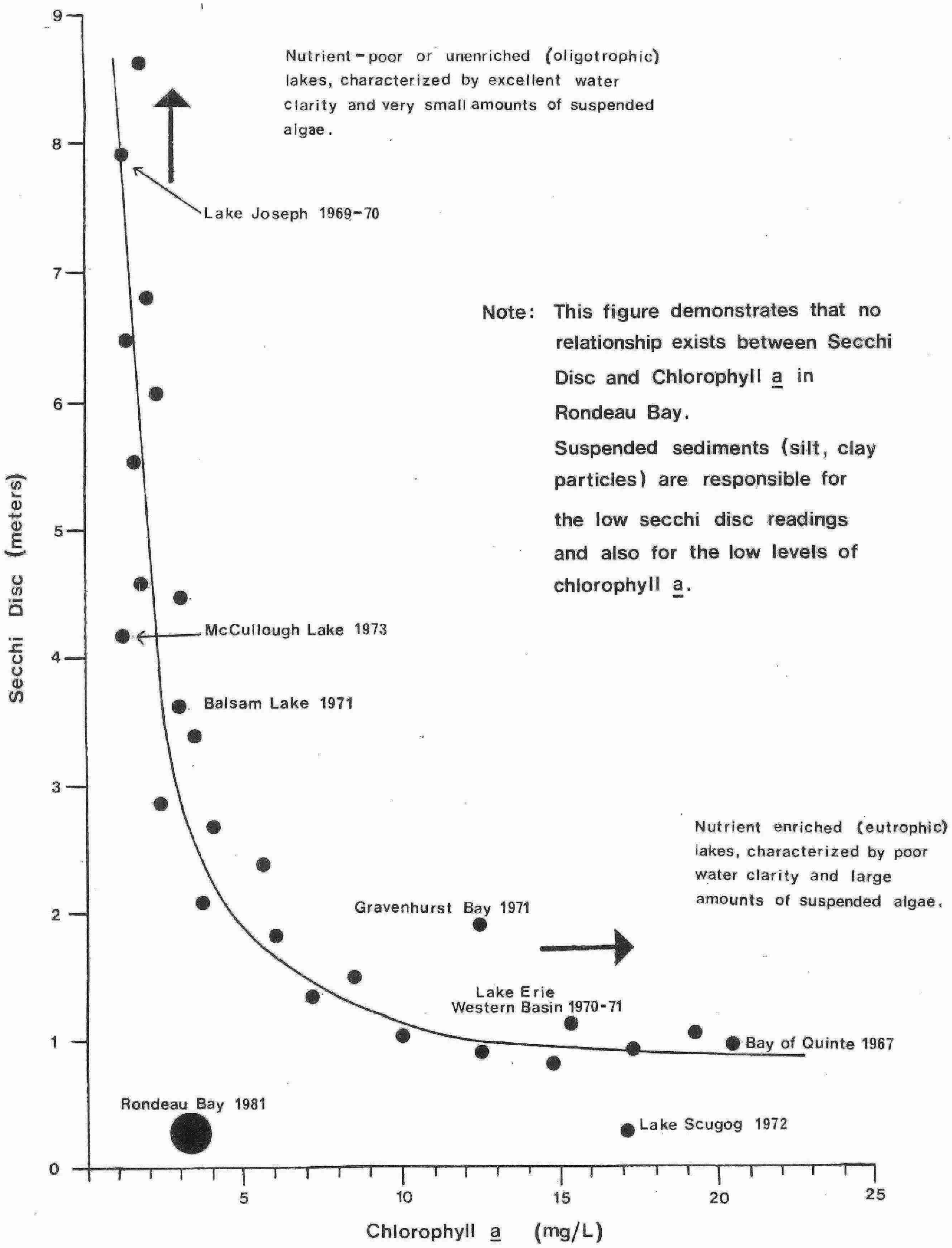

Figure 3. Relationship between Secchi Disc and Chlorophyll a for a number of lakes in Ontario.

Chlorophyll samples were collected during June to August, 1981 at two locations in Rondeau Bay (see Figure 1). Station 1 was located at the deepest area in the north of the Bay and station 2 was located at the deepest area in the south portion of the Bay. Sampling results indicate chlorophyll a and acidified chlorophyll a levels (see Table 5) were unusually low, considering Rondeau Bay has a shallow, nutrient-rich, warm-water environment. Figure 3 graphically depicts chlorophyll levels in Rondeau Bay and compares them to other waters in Ontario. As the graph illustrates, the chlorophyll level in Western Lake Erie at least in 1970 - 71, was about five times as high as was found in Rondeau Bay (1981). The graph also shows Rondeau Bay has low chlorophyll levels, yet very low secchi disc readings. This position on the graph indicates that algae (phytoplankton) is not the cause of water clarity problems in Rondeau Bay. It also clearly substantiates the limiting effect that the turbid waters of the Bay exerts on production of phytoplankton, which is the "grass" of the water so essential to supporting aquatic life.

Table 5 . Summary of the values for Secchi disc (meters) and Chlorophyll a (micrograms per litre) during the summer of 1981 from two locations on Rondeau Bay

Station Location	Date	Secchi Disc (meters)	Chlorophyll a ugm/L	Chlorophyll b ugm/L	Acidified Chlorophyll a ugm/L
Sta #1	July 10	.65	3.4	1.4	1.0
	July 14	.25	2.9	0.9	1.0
	July 23	.2	1.7	0.4	0.7
	July 29	.25	1.9	0.5	0.8
	Aug 3	.35	2.0	0.6	1.0
	Aug 15	.1	4.6	1.2	2.2
	Aug 19	.5	5.5	1.2	2.8
	Aug 25	.4	4.1	1.1	2.6
		Avg. = .34	Avg. = 3.26	Avg. = .91	Avg. = 1.5
		Max. = .65	Max. = 5.5	Max. = 1.4	Max. = 2.8
		Min. = .1	Min. = 1.7	Min. = 0.4	Min. = .7
Sta #2	July 10	.9	1.6	0.8	1.3
	July 14	.4	1.9	0.5	0.8
	July 23	.6	3.4	1.4	2.3
	July 29	.55	2.3	0.5	0.9
	Aug 3	.55	3.6	0.5	1.5
	Aug 15	.25	5.9	0.9	2.3
	Aug 19	.45	5.8	1.1	3.3
	Aug 25	.65	4.3	0.6	3.6
		Avg. = .54	Avg. = 3.6	Avg. = .73	Avg. = 2.0
		Max. = .9	Max. = 5.9	Max. = 1.4	Max. = 3.6
		Min. = .25	Min. = 1.6	Min. = 0.5	Min. = 0.8

6.0 CHANGES IN THE RONDEAU BAY FISHERY

(This section of the report was prepared by the Ministry of Natural Resources Lake Erie Fisheries Assessment Unit.

The Lake Erie Fisheries Assessment Unit of the Ministry of Natural Resources (MNR - Wheatley) recently received a request from the Ministry of the Environment (MOE - London) to define the present status of Rondeau Bay's sport fishery in the context of available historical information. This work was intended to provide additional information for MOE in their study of the water quality on Rondeau Bay.

In defining the status of the fishery, it was decided to use fishery parameters which are normally obtained through creel census surveys such as estimated angling effort (characteristic of the user group) and angler success rates (an index of the relative abundance of a population of fish).

Based on surveys conducted by MNR since 1977, there has been a steady decline in summer angling effort from 95,515 rod-hours (1977) to 29,523 rod-hours (1981). Although direct estimates of angling effort are not available prior to 1977, conversations with camp operators in the Erieau area indicate that in recent years, the number of paid guests during the peak month of July is only one-half of that of the early 1960's. Historical records on the annual number of non-resident licenses sold by issuers at Erieau area currently being research in support of these claims.

Between 1977 and 1980, angler success rates for the highly desirable bluegill and crappie declined steadily.

Furthermore, angler success rates for bluegill, crappie, pumpkinseed, yellow perch, and northern pike during the four-year period between 1977 and 1980 were considerably less than those experienced by anglers between 1950 and 1970. In recent years, the average time required of an angler to catch any fish worthy of keeping has increased to 1 hour and 42 min from 36 minutes during the 1950-70 period.

According to the above, it appears that the quality of the Rondeau Bay fishery, as measured by angler success rates and angling effort, has deteriorated from the levels that were in effect from 1950 to 1970.

The decline in angler success rates probably reflects the loss of fish habitat. Aquatic weeds are required by fish such as largemouth bass, bluegill, crappie, pumpkinseed, and northern pike for reproduction, shelter and feeding. According to several local sources, Rondeau Bay was effectively a giant weed bed in the early 1960's. At that time, difficulties in navigating through the weeds led to mechanical harvesting in certain sections of the bay and the subsequent application of herbicides during various years between 1963 and 1972. In 1982, the areal extent of aquatic weed beds is greatly reduced and they are generally restricted to the west side of the Pointe aux Pins Peninsula and a few isolated patches along the west shore of Rondeau Bay.

Additional stress on the fish populations is being imposed by the high levels of turbidity and siltation, especially after heavy rainfall. High levels of turbidity are known to restrict sight feeders such as bluegill and siltation negatively impacts on the reproductive processes of all nesting fish species.

In summary, the quality of the Rondeau Bay fishery has deteriorated over the past thirty years and this decline has coincided with the loss of fish habitat and high levels of turbidity and siltation. Although some camp-operators maintain that the decline in angling effort is due to the economic conditions in the United States (most anglers have traditionally originated from the U.S.), in a larger part, the decline is probably due to poor angler success rates (Conversations with camp-operator in June, 1982, indicate that many long term U.S.-based patrons are going to alternative locations such as Long Point Bay where they've heard that fishing is considerably better).

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8.0 APPENDIX 1

Water Quality Data June-August 1981

Notation

1) Nitrogens reported as mg/l as N
2) Turbidity in Formazin Units
3) With exceptions of temperature pH and turbidity, data in mg/l

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Monitor Data Card

Stream .... Station 1 .... Description Rondeau Bay

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				pH	Turb.	Susp solids	chlorides Cl		
				Total	Fecal	Strep	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 2/81		18.5					0.034	0.002	0.025	0.47	0.005	0.14	8.34	9 6	11.2	11.0		
June 4/81		17.5					0.029	0.018	0.120	0.64	0.014	0.23	7.89	43.0	20.1	17.0		
June 10/81		18.0					0.037	0.001	0.020	0.44	0.008	0.19	8.18	5.5	4.9	12.0		
June 18/81		20.0					0.052	0.008	0.015	0.53	0.034	0.59	8.28	-	8.9	-		
June 23/81		19.5					0.040	0.004	0.050	0.52	0.027	0.41	8.38	12.0	9.8	-		
June 28/81		-					0.108	0.050	0.005	0.52	0.002	1.41	7.84	-	37.3			
July 5/81		-					0.035	0.011	0.110	0.48	0.016	0.29	8.23	-	6.6	-		
average							0.047	0.013						17.52	14.1			

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Monitor Data Card

Stream.................... Station 2 .... Description Rondeau Bay ....

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml Total	Fecal	Strep	Phosphorus Total	Sol	Nitrogens F A	Kjel	Nitrite	Nitrate	pH	Turb.	Susp. Solids	Chloride as Cl		
June 2/81		18.0					0.021	0.001	0.025	0.40	0.005	0.14	8.35	5.1	6.9	17.0		
June 4/81		18.0					0.065	0.003	0.040	0.41	0.005	0.12	8.21	5.3	4.5	17.0		
June 10/81		19.0					0.116	0.022	0.140	0.86	0.025	1.05	8.16	4.5	29.5	17.0		
June 18/81		19.5					0.066	0.006	0.010	0.62	0.020	0.35	8.09	-	25.8	-		
June 23/81		19.5					0.047	0.006	0.075	0.56	0.028	0.49	8.32	14.0	10.2			
June 28/81		-					0.098	0.020	0.005	0.54	0.001	0.62	7.96	-	37.9	-		
July 5/81		-					0.126	0.026	0.385	0.78	0.100	0.68	8.17	-	33.4			
Average.							0.077	0.012						17.35	21.17			

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Monitor Data Card

Stream .... Station 3 .... Description Rondeau Bay

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				pH	Turb	Susp. solids	Chloride as Cl		
				Total	Fecal	Strep.	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 2/81		18.0					0.032	0.001	0.035	0.48	0.005	0.14	8.35	6.3	8.7	17.5		
June 4/81		19.0					0.590	0.112	0.630	2.10	0.098	1.61	7.81	270.0	220	19.0		
June 10/81		20.0					0.058	0.004	0.015	0.50	0.009	0.21	8.31	22.0	19.3	17.0		
June 18/81		21.0					0.058	0.038	0.010	0.58	0.033	0.58	8.29	-	15.7	-		
June 23/81		20.0					0.066	0.011	0.085	0.58	0.043	0.81	8.25	22.0	15.5	-		
June 28/81							0.224	0.060	0.015	0.76	0.008	1.39	7.77		83.9	-		
July 5/81							0.136	0.024	0.055	0.78	0.123	0.74	8.04	-	35.2	-		
average							0.166	0.037					80.03		56.9			

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Stream.......... Station 4 .... Description Rondeau Bay

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml Total	Fecal	Strep	Phosphorus Total	Sol	Nitrogens F A	Kjel	Nitrite	Nitrate	pH	Turb.	Susp Solids	Chloride as Cl		
June 2/81		17.0					0.024	0.002	0.035	0.55	0.006	0.13	8.41	41	6.7	17.5		
June 4/81		18.5					0.160	0.049	0.160	0.74	0.025	0.40	8.14	82.0	27.7	17.5		
June 10/81		20.0					0.194	0.023	0.080	0.86	0.036	0.48	8.16	95	93	17.5		
June 18/81		22.0					0.160	0.009	0.030	0.76	0.041	0.71	8.13	–	67.6	–		
June 23/81		20.5					0.084	0.024	0.095	0.64	0.045	0.98	8.21	29	17.1			
June 28/81		–					0.232	0.071	0.010	0.82	0.007	1.81	7.66	–	77.4	–		
July 5/81		–					0.152	0.038	0.030	0.82	0.28	0.70	7.76	–	34.8	–		
average							0.144	0.031						52.53	46.33			

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Monitor Data Card

Stream .... Station 5 .... Description Rondeau Bay

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				pH	Turb	Susp. Solids	Chloride as Cl		
				Total	Fecal	Strep	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 2/81		17.0					0.025	0.002	0.035	0.54	0.006	0.14	8.36	4.0	6.2	17.0		
June 4/81		19.0					0.020	0.002	0.040	0.38	0.004	0.11	8.23	3.3	3.3	16.5		
June 10/81		20.0					0.082	0.005	0.045	0.74	0.016	0.38	8.24	35	46.5	17.0		
June 18/81		22.0					0.118	0.020	0.015	0.70	0.044	0.90	8.15	-	42.7	-		
June 23/81		20.0					0.052	0.007	0.075	0.54	0.038	0.62	8.29	17	12.7	-		
June 28/81							.120	0.05	0.015	0.58	0.016	1.35	7.92	-	25.9	-		
July 5/81							0.168	0.031	0.015	0.78	0.049	0.52	7.94	-	42.0	-		
average							0.083	0.17						14.83	25.6			

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Stream .... Station 6 .... Description Rondeau Bay

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml Total	Bacteria / 100 ml Fecal	Bacteria / 100 ml Strep	Phosphorus Total	Phosphorus Sol	Nitrogens F A	Nitrogens Kjel	Nitrogens Nitrite	Nitrogens Nitrate	pH	Turb	Susp Solids	Chloride as Cl		
June 2/81		17.0					0.026	0.001	0.030	0.46	0.006	0.13	8.36	4.6	7.3	17.0		
June 4/81		18.0					0.022	0.001	0.040	0.39	0.005	0.10	8.21	3.7	4.3	16.5		
June 10/81		20.0					0.066	0.003	0.015	0.66	0.013	0.31	8.30	22	28.6	16.5		
June 18/81		22.0					0.074	0.018	0.030	0.62	0.043	0.81	8.17	-	11.9	-		
June 23/81		19.0					0.052	0.008	0.075	0.56	0.038	0.61	8.26	17	12.8	-		
June 28/81							0.065	0.021	0.005	0.55	0.058	0.97	8.05	-	18.6	-		
July 5/81							0.033	0.007	0.095	0.54	0.018	0.45	8.15	-	8.0	-		
average							0.048	0.008						11.83	13.1			

Ontario Ministry of the Environment

Monitor Data Card

Stream .... Station 7 .... Description Rondeau Bay

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				pH	Turb	Susp Solids	Chloride as Cl
				Total	Fecal	Strep	Total	Sol	F A	Kjel	Nitrite	Nitrate				
June 2/81		17.5					0.030	0.001	0.025	0.40	0.005	0.14	8.34	4.5	6.7	17.0
June 4/81		18.5					0.021	0.001	0.040	0.42	0.005	0.11	8.29	3.6	5.0	16.5
June 10/81		20.0					0.142	0.051	0.220	0.92	0.055	0.87	8.20	25	22.8	17.0
June 18/81		22.0					0.086	0.026	0.035	0.58	0.044	0.79	8.17	–	18.8	–
June 23/81		19.0					0.052	0.006	0.075	0.60	0.037	0.63	8.26	13	7.5	–
June 28/81							0.053	0.017	0.160	0.71	0.012	0.52	8.02		11.5	–
July 5/81							0.033	0.010	0.085	0.51	0.066	0.44	8.24	–	4.7	–
average							0.059	0.016						11.53	11.0	

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Stream. .... Station ..8.. Description ..Rondeau Bay..

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml Total	Bacteria / 100 ml Fecal	Bacteria / 100 ml Strep	Phosphorus Total	Phosphorus Sol	Nitrogens F A	Nitrogens Kjel	Nitrogens Nitrite	Nitrogens Nitrate	pH	Turb.	Susp. Solids	Chloride as Cl
June 2/81		17.0					0.022	0.001	0.020	0.38	0.005	0.12	8.34	4.2	6.5	17.0
June 4/81		18.0					0.024	0.009	0.045	0.40	0.005	0.10	8.25	3.7	4.5	17.0
June 10/81		20.0					0.074	0.026	0.160	0.70	0.026	0.50	8.20	23	20.1	16.5
June 18/81		22.0					0.050	0.004	0.005	0.63	0.038	0.76	8.27		11.8	
June 23/81		17.0					0.040	0.006	0.040	0.42	0.021	0.34	8.24	8.4	8.9	
June 28/81							0.049	0.017	0.140	0.62	0.040	0.20	7.83	-	10.6	-
July 5/81							0.039	0.011	0.185	0.63	0.022	0.36	8.07	-	5.1	-
average							0.043	0.009						9.83	8.21	

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Stream .... Station ......|...... Description Drain #1 (Harwich twp.)

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				Turb	chloride	Susp. Solids	pH		
				Total	Fecal	Strep	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 8/81 4:40-6:10							0.136	0.042	0.080	1.20	0.080	7.8	37	29.0	50.9	8.16		
June 8/81 10:10 - 11:30 pm							12.8	3.45	2.7	56.0	1.84	3.0	7500	12.0	20610	7.71		
June 10/81							0.236	0.065	0.085	1.32	0.087	10.7	75	30.0	124	8.07		
June 15/81							0.820	0.151	0.290	3.60	0.26	15.0		27.0	4304	7.62		

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Stream .... Station 2 .... Description Drain # 2 ([illegible]) [illegible]

DATE	D.O. (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				Turb.	Chloride as Cl	Susp. Solids	pH		
				Total	Fecal	Strep	Total	Sol	F.A.	Kjel	Nitrite	Nitrate						
June 8/81 4:40-6:10pm							0.149	0.096	0.140	0.72	0.096	13.8	6.9	45.5	119	8.00		
June 8/81 10:10-11:30pm							21.5	3.65	3.0	55.0	0.20	14.5	>1000	5.0*	23441	*7.30		
June. 10/81							0.194	0.073	0.110	1.16	0.067	15.9	150	43.0	164.4	7.96		
June. 15/81							0.580	0.125	0.110	3.00	0.088	18.9		32.5	239.7	7.66		

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Monitor Data Card

Stream .... Station 3 .... Description Drain #3 ([illegible]) [illegible]

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml Total	Fecal	Strep	Phosphorus Total	Sol	Nitrogens F A	Kjel	Nitrite	Nitrate	Turb	Chloride as Cl	Susp. Solids	pH		
June 8/81 10.10–11.30pm							25.3	4.70	2.3	51.3	0.35	2.1	>1000	5.5	26383	7.46		
June 10/81							0.262	0.046	0.170	1.66	0.119	9.5	150	18.5	164.4	8.00		
June 15/81							0.720	0.094	0.288	3.50	0.25	13.7		17.5	388.2	7.74		

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Monitor Data Card

Stream .... Station 4 .... Description Drain #4 (Ash[illegible]) [illegible]

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				[illegible]	[illegible]	[illegible]	pH		
				Total	Fecal	Strep.	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 8/81 4:30–2:10 pm							0.142	0.023	0.140	1.42	0.143	6.6	5.1	11.5	[illegible]	8.4		
June 8/81 10:10 11:30 pm							.203	3.35	2.9	52.0	0.30	5.4	71	*4.5	[illegible]	*7.5		
June 10/81							0.192	0.053	0.215	1.36	0.012	13.7	74	3.5	[illegible]	7.93		
June 15/81							0.420	0.097	[illegible]	2.50	[illegible]	17.1		5.5	131.7	7.72		

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Monitor Data Card

Stream .... Station 5 Description [illegible] Creek ([illegible]) [illegible]

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml Total	Fecal	Strep	Phosphorus Total	Sol	Nitrogens F A	Kjel	Nitrite	Nitrate	T. t.	[illegible]	[illegible]	pH		
June 8/81 [illegible] 10 am							0.136	0.042	[illegible]	1.35	0.141	11.6	3.7	32.0	[illegible]	[illegible]		
June 8/81 11:10 11:30 pm							14.0	4.40	23	41.0	0.45	2.2	[illegible]	15	[illegible]	7.7		
June 10/81							0.294	[illegible]	[illegible]	1.50	0.050	7.7	16.5	20.0	[illegible]	[illegible]		
June 16/81							1.25	0.167	0.415	4.25	0.143	10.4		14.5	1034	7.79		

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Monitor Data Card

Stream.................................... Station......6............. Description..Drain #6 (Harwick drain) *cross-legal

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				Turb.	Chloride	[illegible]	pH		
				Total	Fecal	Strep	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 8/81	[illegible]	pm					0.170	0.054	0.240	1.44	0.114	8.9	9.8	[illegible]	64.	8.09		
June 8/81	[illegible]	3 pm					18.8	4.30	3.1	63.0	0.25	3.6	7100	5.0	3472	7.6		
June 10/81							0.172	0.110	0.190	1.28	0.043	13.2	[illegible]	43.0	14.9	7.48		
June 12/81							0.440	0.174	[illegible]	2.00	0.041	11.5		36.0	19.6	7.3		

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Monitor Data Card

Stream .... Station 7 .... Description Drain #7 ([illegible]) [illegible]

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml Total	Fecal	Strep	Phosphorus Total	Sol	Nitrogens F A	Kjel	Nitrite	Nitrate	Turb.	[illegible]	[illegible]	pH		
June 8/81	9:40 - [illegible] pm						0.138	0.044	0.540	1.86	0.120	13.3	22	45.5	31.4	7.82		
June [illegible]/81	10:10 - 10:30 pm						248	575	4.5	68.0	0.40	3.7	71000	*5.0	34729	7.69		
June 10/81							0.164	0.058	0.095	1.16	0.048	9.3	95	17.5	63.1	8.02		
June 15/81							0.330	0.082	0.105	1.90	0.049	10.0		22.5	198.7	7.76		

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Monitor Data Card

Stream .... Station 8 .... Description Mill Creek [illegible]

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				[illegible]	[illegible]	[illegible]	[illegible]		
				Total	Fecal	Strep.	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 8/81	@ [illegible] pm						[illegible]	[illegible]	[illegible]	[illegible]	0.101	7.4	[illegible]	[illegible]	55.0	7.93		
June 8/81	@ 10-11 am						31.5	3.45	2.5	34.0	0.30	3.0	>1000	3.5	63.251	7.75		
June 10/81							[illegible]	[illegible]	[illegible]	1.3	0.079	5.3	[illegible]	24.0	80.8	7.93		
June 15/81							0.280	0.096	0.240	2.10	0.140	9.6		30.5	124.8	7.80		

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Monitor Data Card

Stream .... Station 9 .... Description Drain #9 ([illegible]) [illegible]

DATE	D O (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				Turb	Chloride [illegible]	Susp. Solids	pH		
				Total	Fecal	Strep	Total	Sol	F A	Kjel	Nitrite	Nitrate						
June 8/81	4:00-6:10 pm						0.150	0.034	0.560	1.52	0.101	7.4	4.2	30.5	55.0	7.93		
June 8/81	10:00-11:30 pm						16.3	3.50	2.7	28.8	0.45	2.9	[illegible]	55	5370	7.0[illegible]		
June 10/81							0.680	0.132	0.682	3.40	0.168	16.7	270	310	3181	7.82		
June 15/81							0.600	0.187	0.860	3.60	0.151	11.7		320	[illegible]	7.6		

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Stream .... Station 10 .... Description Georgie Drain (Harwich twp)

DATE	D.O. (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria /100 ml Total	Fecal	Strep	Phosphorus Total	Sol.	Nitrogens F.A.	Kjel.	Nitrite	Nitrate	Turb	Chloride as Cl	Susp Solids	pH
June 8/81	4:40 6 10pm						0.430	0.165	0.700	1.78	0.32	5.6	43	49.5	71.0	8.02
June 8/81	10.10-11:30pm						0.570	0.052	0.140	3.46	0.38	5.0	220	52.0	468.1	7.90
June 10/81							0.246	0.077	0.310	1.60	0.140	7.1	73	32.5	1044	7.87
June 15/81							0.410	0.184	0.395	2.40	0.138	12.3		42.5	130.2	7.54

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Stream .... Station .. 11 .... Description .. Harwich twp. Drain # 11 ......

DATE	D.O. (mg/l)	Temp °C	BOD_5 (mg/l)	Bacteria / 100 ml			Phosphorus		Nitrogens				Turb	Chloride as Cl	Susp Solids	pH		
				Total	Fecal	Strep	Total	Sol	F.A.	Kjel	Nitrite	Nitrate						
June 8/81 4:40-6:30pm							0.286	0.057	0.495	2.66	0.172	7.4	130	25.0	104.0	7.90		
June 8/81 10:10-11:30pm							0.2	0.060	0.775	2.20	0.34	14.5	65	31.5	100.5	7.91		
June 10/81							0.495	0.015	0.260	1.50	0.045	1.48	240	19.5	226.7	8.16		
June 15/81							0.730	0.230	0.705	3.50	0.230	7.42		21.5	198.6	7.53		

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